Title: Swimming in Data

Brief Overview:
This concept development unit seeks to develop student understanding of two skills crucial to the statistical analysis of data: understanding when to use mean, median, or mode as the correct measure of central tendency and creating stem and leaf plots to graphically represent data. The skills are taught using data from the sport of swimming and within the broader concept of the United States Olympic Swim Team. Spotlighted in the unit are two well-known American Olympic Swimmers, Michael Phelps and Dara Torres. The students will use these swimmers to determine "typical" and "outlier" data within a set. Using this unit to explore the concepts, students are able to create their own data by investigating how large a bubble they can blow (measurement of diameter) and participate in a simulation where they are members of a "class swim team."

NCTM Content Standard:
Find, use, and interpret measures of center and spread, including mean and inter quartile range.

Discuss and understand the correspondence between data sets and their graphical representations, especially histograms, stem-and-leaf plots, box plots, and scatter plots.

Grade/Level:

5/6

Duration/Length:

Three sixty minute lessons

Student Outcomes:

Students will:

- Interpret and compare data using a stem and leaf plot.
- Apply and analyze the measures of central tendency to solve a problem or answer a question.
- Justify ideas or solutions with mathematical concepts or proofs.
- Present mathematical ideas using words, symbols, and visual displays.
- Relate or apply mathematics within the discipline to life.

Materials and Resources:
Day 1

- Student resource "Pre-assessment"
- Teacher resource "Pre-assessment Answer Key"

- Student resource “Freestyle Times”
- Student resource “Definitions”
- Student resource “Backstroke Times”
- Teacher resource “Backstroke Times Answer Key”
- Student resource “Breaststroke Times”
- Teacher resource “Breaststroke Times Answer Key”
- Student resource “Butterfly”
- Teacher resource “Butterfly Answer Key”
- Student resource “Checklist”
- Teacher resource “Checklist Answer Key”
- Student resource “2008 Medal Totals for Summer Olympics”
- Teacher resource “2008 Medal Totals for Summer Olympics Answer Key”
- Student resource “Day 1 Exit Card”

Day 2

- Student resource “US Men’s Olympic Swim Team Roster”
- Student resource “Stem and Leaf Plot”
- Teacher resource “Stem and Leaf Plot Answer Key”
- Student resource “Men’s 100m Butterfly”
- Teacher resource “Men’s 100m Butterfly Stem and Leaf Answer Key”
- Teacher resource “Blowing Bubbles”
- Index cards – one for each student
- Student resource “Stem and Leaf Bubbles”
- Student resource “Cutting and Pasting”
- Teacher resource “Cutting and Pasting Answer Key”
- Student resource “Back to Back Stem and Leaf Plot”
- Teacher resource “Back to Back Stem and Leaf Plot Answer Key”
- Student resource “Day 2 Exit Card”
- Teacher resource “Day 2 Exit Card Answer Key”

Day 3

- Student resource “World Oceans”
- Teacher resource “World Oceans Answer Key”
- Student resource “Definition of Outlier”
- Student resource “Swimming Earplugs”
- Teacher resource “Swimming Earplugs Answer Key”
- Student resource “Is Dara Torres an Outlier?”
- Teacher resource “Is Dara Torres an Outlier Answer Key”
- Student resource “Outlier Finder”
- Teacher resource “Outlier Finder Answer Key”
- Student resource “US Women’s Olympic Swimming Team Ages”
- Teacher resource “US Women’s Olympic Swimming Team Ages Answer Key”

- Student resource "Summative Assessment"
- Teacher resource "Summative Assessment Answer Key"

Development/Procedures:

Day 1

Pre-assessment

- Distribute the student resource "Pre-assessment." This will help to determine any misconceptions within the concepts being taught within these lessons. An answer key is included.

Engagement

Begin class with a class discussion using the following questions:

- Where can you go swimming? (Make sure to discuss different locations such as lake, pond, pool, ocean, etc.)
- When do you normally swim? (Can swim all year with indoor pool, or others might only swim during certain seasons)
- Why is swimming considered a sport?
- What are the different types of swimming strokes?
- Who swims on a swim team?

Exploration

- Pose the following scenario to the class. The entire class is on a swim team but only half of the team can travel to participate in the State Regional Swim Meet. As a class discuss the criteria for making the travel team.
- Students in the class will randomly select their fastest swimming time for freestyle by picking a time out of a bag (see student resource "Freestyle Times").
- Have the class organize themselves to easily see who would make the travel team for freestyle (Hint – have students line up least to greatest).
- Remind students that the lower the time, the faster they have swam.
- While it is important to make the team, it is also important to know the "typical" swim time within that smaller group. That way you will know what time you need to beat in order to be faster than the rival team.
- Since the travel team is in order from least to greatest, discuss ways to find the typical values within the group (mean, median, mode – define/review if necessary).
- Calculate the mean, median and mode of the data set.
- Ask the class what the "typical" swim time would be for our class team based on the data.

Explanation

- Ask for student opinions on when would the center of the data best be represented by mean, median, or mode. Chart their responses on the board.

- Discuss the justification for using each measure of central tendency to describe data.
    - Mean – the data is close together and there are no outliers/extremes.
    - Median – the data has a large range and there may be an outlier or extremes that could skew the data
    - Mode – the majority of the values are the same, there may be an outlier
- Distribute the half-sheet, student resource "Choosing Measures of Center."
- Now that the students have this information, have them discuss the "typical" time for a team member to swim a lap using freestyle. As a class, write one to two sentences justifying their answer.
- Guided Practice – The swim coach wants to know the "typical" time it takes a member of his team to swim each of the three strokes, backstroke, breaststroke and butterfly. This way, each team member can compare their swimming times among the team. Have a student demonstrate the strokes and how they are slower than the freestyle stroke.
- Beginning with backstroke, select 8 to 10 students to choose times out of a hat (see student resource "Backstroke Times").
- Have students line up least to greatest so that the class can see the values.
- Ask the class, based on this data, what measure of central tendency they would use to describe the "typical" time for a team member to swim the backstroke. Ask the students to defend their answers using math vocabulary. They may use their student resource "Choosing Measures of Center" to help them. An answer key is provided.
- Divide the class into groups of four or five and distribute the student resource "Breaststroke Times." All groups have the same values. Within their groups, the students are to decide which measure of central tendency best represents the data.
- Have the students write their answers using math vocabulary. Share each group's response and decide as a class which measure of center would best reflect the typical time.
- Write their responses on the board to use as a model for their application/independent work. Highlight math vocabulary as a class to point out a good example. An answer key is provided.

Application

- Distribute student resource "Butterfly" to the students to complete independently. Walk around the room to monitor student understanding. An answer key is provided.

Differentiation

Reteach

Meet with students who are struggling during the group lesson or the independent class work. Distribute the student resource "Checklist" to those students. Go through each

scenario using the checklist to help determine which measure of central tendency would best describe the data. A answer key is provided.

Enrich

Give students the data from the 2008 Summer Olympics total Medals. Students are to input this data into an Excel Spreadsheet. They are then to follow the directions on the worksheet to calculate the mean, median, and mode of the data using Excel. Students will then write about how the United States and China's medal count skewed the data, (See student resource "2008 Medal Totals for Summer Olympics").

Assessment
Students will complete an exit card (See student resource "Day 1 Exit Card").

Day 2

Engage

www.nbcolympics.com/video/index.html

Above is a link for a video of Michael Phelps. Click on the link, and then search for Michael Phelps.

Today in class we are going to explore whether or not Michael Phelps is a typical swimmer. Ask the class to tell what they know about Michael Phelps and why he is famous. If you have access to do so, show the video to the class. It is three minutes long. He was famous for winning 8 gold medals in the 2008 Olympics for the United States.

http://www.usaswimming.org/DesktopDefault.aspx?TabId=1453&Alias=Rainbow&Lang=en&biosid=4beec290-d7ae-483d-a512-36b18a4e022a
This is a link to Michael Phelps' biography online.

Exploration

- Say: "Today we are going to explore whether or not Michael Phelps is a typical Olympic swimmer. First, we are going to investigate his age. Based on yesterday's lesson, how should we determine whether or not Michael Phelps is the "typical" Olympic swimmer.
- Distribute student resource "US Men's Olympic Swim Team Roster" and discuss ways to display this data.
- Because the age data is close together, students usually create a line plot for this type of data. Today they are going to learn how to create a stem and leaf plot when there is a lot of data within one stem.

Explanation

- Distribute the student resource "Stem and Leaf Plot." Have students look at the stem and leaf plot and ask how it is different from stem and leaf plots they have done in the past. Students should notice there are dots in between the stems. Ask students what these dots represent (dots separate the values by fives).
- The first person on the roster is Nathan Adrian. He is 19 years old. Ask for volunteers to come to the board to see if they can correctly place the age in the correct stem. If the person is right, ask the class why. If the student is wrong, ask the class to help the student correct their placement. Continue with four other students.
- Have the students use the data to complete the stem and leaf plot at their seats.
- As a class, make a key for the stem and leaf plot.
- Ask students if they are clear on how to make the stem and leaf plot. Review the data and ask students if Michael Phelps is the "typical" age of a US Men's Olympic swimmer. They must use math vocabulary to defend their answer. They might want to use the student resource "Measures of Center" from yesterday's lesson to help them justify their answers. An answer key is provided.
- Distribute the next student resource page "Men's 100 Meter Butterfly" (times have been rounded to the nearest tenth). Look at the data as a class. What is different about this data compared to the last set of data? (Data is in decimals) How can we create a stem and leaf plot with decimals? (Whole number as stem, decimal value as leaf) Distribute student resource "Men's 100m Butterfly Stem and Leaf."
- Ask the class for the appropriate stems, using the dots as in the previous example. Model on the board as students complete their own plots at their seats.
- Show the first five times on the board. Then, have students complete it on their own. When everyone is finished, ask students for an appropriate key to add to the class list.
- Ask which measure of central tendency best describes the data? Does Michael Phelps have a "typical" time for this race? An answer key is provided.

Application

- Olympic swimmers need large lung capacities. Students will test their lung capacity to see how large a bubble they can create at their seats. Students are to create five bubbles and measure the diameter (define if needed) of the bubble. They are to record their five values on an index card. Have student write the value of their largest bubble on the board (See teacher resource "Blowing Bubbles" for directions on how to make bubble mixture).
- Once the class data is collected, wipe the desks clean and dry them. Distribute student resource "Stem and Leaf Bubbles" and have students create a stem and leaf plot using dots to separate the values into fives. While students are working, check for understanding.
- Once students have completed the stem and leaf plot, they can complete the Brief Constructed Response on student resource "Bubble Talk" describing the typical size of a class bubble.
- Share responses as a class. Emphasize good uses of math vocabulary.

Differentiation

Reteach

Reviewing the process of creating regular stem and leaf plots. Use the student resource "Cutting and Pasting." Students will need scissors and glue for the activity.

Enrich

Using the data from the application, have the students create a back to back stem and leaf plot. Distribute student resource "Back to Back Stem and Leaf Plot." Students can use one stem to compare the size of bubbles created by boys versus girls. Be sure to include a key on both sides of the stem and leaf plot.

Assessment

Given a set of data, students will complete a stem and leaf plot and choose which measure of central tendency best describes the data. Distribute student resource "Day 2 Exit Card." An answer key is provided.

Day 3

Engage

- Say: "Today we are going to be learning about another swimmer, Dara Torres. Her biography can be found at: http://daratorres.com/bio.php. While she did not earn as many medals as Michael Phelps, her story is very compelling since she was 41 during the 2008 Olympics."
- Say: "Today, we are going to find out if Dara Torres represents the typical age of an Olympic Swimmer."

Exploration

- One place that you can go swimming is in the ocean. Some races, including the Iron Man, has swimmers in the ocean and is called Open Water Swimming. Of the five oceans, which would be the best to swim across, if it were humanly possible? See student resource "World Oceans."
- What do you notice about the sizes of the oceans? Does one seem larger than another? Why? (Someone should mention that the Pacific Ocean is more than twice the size of the Atlantic Ocean.)
- If the Pacific Ocean is so much larger, would you consider it an extreme or an outlier? What constitutes an outlier?

Explanation

- Make a class list of student ideas as to what an outlier is. Ask the students how they can determine an outlier. Inform students that in order to determine an outlier, you first must find the median and both the upper and lower quartiles of the data. *Note, when finding the upper and lower quartile, the median can not be used as a value.

- Once both quartiles are found, calculate the interquartile range by subtracting the upper quartile minus the lower quartile.
- Multiply the Interquartile range by 1.5. Take that value and add it to the upper quartile or subtract if from the lower quartile. (student resource "Definition of Outlier").
- Once students have calculated the value, they need to decide if the Pacific Ocean really is an outlier. It looks like an outlier, but according to our data, an outlier needs to be above 265.75 million km. Therefore, the Pacific Ocean is not an outlier after all!
  Let's look at another set of data. This time, we are looking at the amount of swimming ear plugs used in an Olympic swimmer's career. On student resource "Swimming Earplugs" determine whether Amanda Beard's number of swimming ear plugs is an outlier. An answer key is provided.

Application

- Students should work independently on the student resource "Is Dara Torres an Outlier," to discover if Dara Torres' age is really an outlier. Students should complete the stem and leaf plot, show their work for computing the interquartile range, and write a brief **co**nstructed response on whether or not Dara Torres' is indeed an outlier, as the media portrayed her to be. An answer key is provided.
- Monitor student understanding and progress.

Differentiation

Reteach

Work with those students who did not understand the lesson in a small group to discuss the meaning of an outlier. Use student resource, "Outlier Finder" to reinforce this concept. An answer key is provided.

Enrich

Students can take the data from the student resource, "US Women's Olympic Swimming Team Ages," and create a box and whisker plot of the data. This shows the information in a different way. Look at the 1984 Summer Olympics medal data if you need another set of data to use with an outlier for box and whisker plots. If you have Internet access, the National Library of Virtual Manipulatives has a program that allows students to input their data and it will create a box and whisker plot for them. The link is: http://nlvm.usu.edu/en/nav/frames_asid_200_g_3_t_5.html?open=instructions&from=category_g_3_t_5.html.

Summative Assessment:

Students will complete the task of determining whether the United States' number of medals won by country during the 2010 Winter Olympics would be considered an outlier. Students will also be required to find and justify the typical number of medals won during that year's Olympics. Distribute student resource "Summative Assessment." An answer key is provided.

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Pre-Assessment

Name: _____

Directions:
I. Match the measure of central tendency that best represents the data below.

A. Mean B. Median C. Mode

_____ 1. 7, 7, 7, 7, 8, 4, 7, 7

_____ 2. 8, 9, 10, 7, 12, 16, 15, 13

_____ 3. 1, 13, 17, 20, 14, 16, 15, 14

II. Sara decided to work as a waitress over the summer. Below is a list of her earnings each day. Create a stem and leaf plot to display her data.
$12, $19, $20, $25, $21, $22, $23, $24, $26, $23, $22, $27, $16, $29, $23, $24, $22, $20, $27, $18, $20

Pre-Assessment Answer Key

Name: _____

Directions:
I. Match the measure of central tendency that best represents the data below.

A. Mean B. Median C. Mode

__C___ 1. 7, 7, 7, 7, 8, 4, 7, 7

__A___ 2. 8, 9, 10, 7, 12, 16, 15, 13

__B___ 3. 1, 13, 17, 20, 14, 16, 15, 14

II. Sara decided to work as a waitress over the summer. Below is a list of her earnings each day. Create a stem and leaf plot to display her data.
$12, $19, $20, $25, $21, $22, $23, $24, $26, $23, $22, $27, $16, $29, $23, $24, $22, $20, $27, $18, $20

Sara's Earnings

1	2
•	6 8 9
2	0 0 0 1 2 2 2 3 3 3 4 4
•	5 6 7 7 9

Freestyle Times

78 F	64 F	85 F	92 F	82 F
70 F	90 F	68 F	79 F	101 F
73 F	93 F	69 F	80 F	75 F
82 F	102 F	71 F	87 F	78 F
82 F	88 F	85 F	69 F	61 F
86 F	77 F	77 F	83 F	94 F

Using Measures of Center

~~Definitions~~

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Name: _____

Vocabulary 	When to  Use~~Definition for Use~~	Example 
Mean	Use when the data is close together and there are no extremes	1, 2, 5, 5, 7, 9, 10
Median	Use when the data has a very large range and there may be an extreme	1, 2, 5, 5, 7, 9, 100
Mode	Use when the majority of the values are the same	1, 2, 5, 5, 5, 5, 5, 5, 5

Definitions

Name: _____

Vocabulary 	When to~~Definition for~~ Use 	Example 
Mean	Use when the data is close together and there are no extremes	1, 2, 5, 5, 7, 9, 10
Median	Use when the data has a very large range and there may be an extreme	1, 2, 5, 5, 7, 9, 100
Mode	Use when the majority of the values are the	1, 2, 5, 5, 5, 5, 5, 5, 5

	same	

7 0 Backstroke	7 2 Backstroke	7 2 Backstroke	7 2 Backstroke	7 2 Backstroke

7	7	7	7	7
4	3	2	2	2
Backstroke	Backstroke	Backstroke	Backstroke	Backstroke

Backstroke Times

 # Backstroke Times 

Teacher Resource / Answer Sheet

Order – 70,72,72,72,72,72,72,72,73,74

Median – 72

Mean – 72.1

Mode – 72

Students will see that using the mode is the best measure of central tendency.
The backstroke times of the team illustrate that you can use the mode to express the "typical" backstroke swim time. Consequently, the students realize sometimes you don't have to take the time to calculate mean or median.

Breaststroke Times

98 BS	97 BS	96 BS	96 BS	95 BS
95 BS	95 BS	94 BS	94 BS	93 BS
93 BS	93 BS	92 BS	92 BS	92 BS
91 BS	210 BS	91 BS	90 BS	90 BS
90 BS	90 BS	89 BS	89 BS	88 BS
87 BS	87 BS	87 BS	86 BS	85 BS

 # Breaststroke Activity 

Answer Key

Order – 210,97,96,96,95,95,95, 94,94,93,93,93,92,92,92,91,91,90,90,90,90,89,89,88,87,87,87,86,85

Median – 92
Mode – 90
Mean – 95.5

Due to the student who swam 100 m in 210 seconds the measure of central tendency that best describes the typical breaststroke time is the **median**. The **mode** doesn't describe a typical breaststroke time, because there are only four numbers with that time in the data set of 30.

Name: _____

Butterfly

Directions: Use the following 100m times to find the "typical" butterfly time for a member of the rival team. "Typical" times are calculated by finding the mean, median, and mode of the data.

Name	Time (Seconds)
Mike	78
Christy	77
Noel	78
Shayla	76
Dave	77
Jim	79
Lisa	80
Susan	75
Megan	81
Xavier	77

Based on the rival team's data, what measure of central tendency would best describe the "typical" swimmer.

_____

Describe the reason why you chose the mean/median/mode. Make sure to use math vocabulary in your explanation.

_____

_____

_____

_____

_____

Name: _____

Butterfly

Directions: Use the following 100m times to find the "typical" butterfly time for a member of the rival team. "Typical" times are calculated by finding the mean, median, and mode of the data.

Name	Time (Seconds)
Mike	78
Christy	77
Noel	78
Shayla	76
Dave	77
Jim	79
Lisa	80
Susan	75
Megan	81
Xavier	77

Based on the rival team's data, what measure of central tendency would best describe the "typical" swimmer.

____Mean_____

Describe the reason why you chose the mean/median/mode. Make sure to use math vocabulary in your explanation.

Answers will vary

I calculated the mean to decide the "typical time of the rival swim team's butterfly results, because of the small range of the data and the absence of an extreme/outlier._____

Name:_____

Checklist

Look at the **variety** of numbers – If there is one number that is the majority of the data set, then use **Mode** as the best measure of central tendency.

Look at the **range** of the data (Largest # - Smallest #).

If the range is a *small #* -- Calculate the **Mean** as the best measure of central tendency.
If the range is a *large #* -- Order the data from least to greatest and find the **Median** to best represent the measure of central tendency.

Number of Points Scored	
Game	Points
1	27
2	29
3	35
4	21
5	2
6	21
7	25
8	12

Are there a majority of different numbers?
_____

Is the range small or large?
_____

Circle Best Measure:

Mean Median Mode

Number of Points Scored	
Game	Points
1	27
2	25
3	35
4	25
5	12
6	25
7	25
8	25

Are there a majority of different numbers?
_____

Is the range small or large?
_____

Circle Best Measure:

Mean Median Mode

Number of Points Scored	
Game	Points
1	27
2	29
3	32
4	25
5	22
6	24
7	25
8	26

Are there a majority of different numbers?
_____

Is the range small or large?
_____

Circle Best Measure:

Mean Median Mode

Name:_____

Checklist

 Look at the **variety** of numbers – If there is one number that is the majority of the data set, then use **Mode** as the best measure of central tendency.

 Look at the **range** of the data (Largest # - Smallest #).

If the range is a *small* # -- Calculate the **Mean** as the best measure of central tendency.

If the range is a *large* # -- Order the data from least to greatest and find the **Median** to best represent the measure of central tendency.

Number of Points Scored	
Game	Points
1	27
2	29
3	35
4	21
5	2
6	21
7	25
8	12

Are there a majority of different numbers?
____No___

Is the range small or large?
____Large_____

Circle Best Measure:

Mean Median Mode

Number of Points Scored	
Game	Points
1	27
2	25
3	35
4	25
5	12
6	25
7	25
8	25

Are there a majority of different numbers?
_____Yes_____

Is the range small or large?
_____

Circle Best Measure:

Mean Median Mode

Number of Points Scored	
Game	Points
1	27
2	29
3	32
4	25
5	22
6	24
7	25
8	26

Are there a majority of different numbers?
____No____

Is the range small or large?
____Small_____

Circle Best Measure:

Mean Median Mode

Name: _____

2008 Medal Totals for Summer Olympics
Using Excel

Directions – Type the data below into an Excel spreadsheet. Then, follow the directions below to calculate the measures of central tendency. When you start, be sure to put your name on your spreadsheet.

United States	110
China	100
Russia	72
Great Britain	47
Australia	46
Germany	41
France	41
South Korea	31
Italy	27
Ukraine	27
Japan	25
Cuba	24
Belarus	19
Spain	18
Canada	18
Netherlands	16
Brazil	15
Kenya	14
Kazakhstan	13
Jamaica	11
Hungary	10
Poland	10
Norway	9
New Zealand	9
Romania	8
Turkey	8
Ethiopia	7
Denmark	7
Switzerland	7
Azerbaijan	7
Czech Republic	6
Slovakia	6
Georgia	6
North Korea	6
Argentina	6
Uzbekistan	6
Armenia	6
Slovenia	5
Bulgaria	5
Indonesia	5
Sweden	5
Croatia	5
Lithuania	5
Mongolia	4
Thailand	4
Zimbabwe	4
Finland	4
Greece	4
Nigeria	4
Chinese Taipei	4
Mexico	3
Latvia	3
India	3
Austria	3
Ireland	3
Serbia	3
Belgium	2
Dominican Rep.	2
Estonia	2
Portugal	2
Iran	2
Trinidad and Tobago	2
Algeria	2
Bahamas	2
Colombia	2
Kyrgyzstan	2
Morocco	2
Tajikistan	2
Cameroon	1
Panama	1
Tunisia	1
Chile	1
Ecuador	1
Iceland	1
Malaysia	1
South Africa	1
Singapore	1
Sudan	1
Vietnam	1
Afghanistan	1
Egypt	1
Israel	1
Moldova	1
Mauritius	1
Togo	1
Venezuela	1

2008 Medal Totals for Summer Olympics

Once you have input your data into the spreadsheet, have Excel calculate the mean, median and mode for you.

1. To calculate the mean, click on a blank cell and type =AVERAGE (type the cell at the top of the column : type the cell at the bottom of the column).
    a. Example: =AVERAGE (F1:F86)

2. To calculate the median, click on the blank cell below the one you just used and type =MEDIAN(type the cell at the top of the column : type the cell at the bottom of the column).
    a. Example: =MEDIAN (F1:F86)

3. To calculate the median, click on the blank cell below the one you just used and type =MODE(type the cell at the top of the column : type the cell at the bottom of the column).
    a. Example: =MODE F1:F86)

4. Label each measure of central tendency on your paper. Also, make sure your name is on the spreadsheet at the top.

5. Print your spreadsheet for your teacher and staple it to this page to turn in.

6. Explain how the medal totals for both the US and China skewed the data. How did their values affect the measures of central tendency? Make sure to include math vocabulary in your answer.

_____

_____

_____

_____

_____

2008 Medal Totals for Summer Olympics – Answer Key

Mean = 11.12791
Median = 4.5
Mode = 1

6. Explain how the medal totals for both the US and China skewed the data. How did their values affect the measures of central tendency? Make sure to include math vocabulary in your answer.

The United States earned 110 medals and China earned 100 medals in all during the 2008 Summer Olympics. Many of the other countries earned fewer medals than that, which raises the mean to a higher value of 11. The median would be a better measure of central tendency to describe this data since there is a large range within the data and there are extremes.

Day 1 Exit Card

Name: _____

Directions – Tell when to use each measure of central tendency to best describe data.

1. Mean -

   _____

2. Median –

   _____

3. Mode -

   _____

Day 1 Exit Card

Name: _____

Directions – Tell when to use each measure of central tendency to best describe data.

1. Mean -

   _____

2. Median –

   _____

3. Mode -

   _____

US Men's Olympic Swim Team Roster

(2008 Summer Olympics)

Name	Age	Hometown
Nathan Adrian	19	Washington
Ricky Berens	20	North Carolina
Ian Crocker	25	Maine
Mark Gangloff	25	Ohio
Matt Grevers	23	Illinois
Brendan Hansen	26	Pennsylvania
Larsen Jensen	22	California
Cullen Jones	24	New Jersey
Klete Keller	26	Arizona
Jason Lezak	32	California
Ryan Lochte	23	Florida
Aaron Peirsol	24	California
Michael Phelps	23	Maryland
Eric Shanteau	24	Georgia
Scott Spann	20	Texas
Gil Stovall	22	Tennessee
Peter Vanderkaay	24	Tennessee
Erik Vendt	27	Massachusetts
David Walters	20	Virginia
Mark Warkentin	28	California
Garrett Weber-Gale	22	Wisconsin
Ben Wildman-Tobriner	23	California

Stem and Leaf Plot

1

•

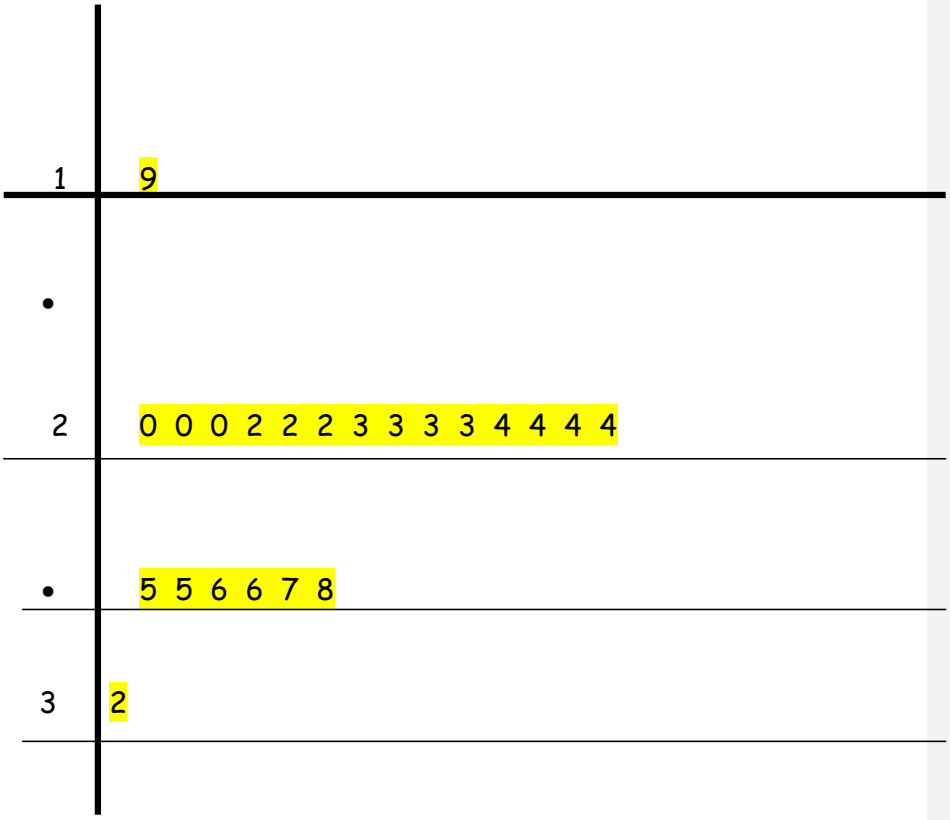
2

•

3

Stem and Leaf Plot Answer Key

_____2008 US Men's Olympic Swimming Team _____



Key:
1|9 = 19 years old

Student Resource: Olympic Time Trials Results

Men's 100M Butterfly

2008 U.S. Olympic Team Trials

Swimmer	Time (seconds)
Michael Phelps	51.1
Ian Crocker	51.5
Gil Stovall	51.9
Tyler McGill	52.2
Chris Brady	52.4
Bobby Bollier	52.6
Davis Tarwater	52.6
Peter Verhoef	52.8
Jayme Cramer	53.0
Matt Grevers	53.2
Kyle Bubolz	53.2
Ricky Berens	53.4
Matt Marshall	53.4
Matt Donch	53.4
Tom Randall	53.9
Logan Madson	54.0

Name:_____

Men's 100M Butterfly
2008 U.S. Olympic Team Trials

51	
•	
52	
•	
53	
•	
54	

Key

|

Men's 100M Butterfly
2008 U.S. Olympic Team Trials Answer Key

51	1
•	5 9
52	2 4
•	6 8
53	0 2 2 4 4 4
•	9
54	0

Key

51 | 1 = 51.1 seconds

Bubble Blowing

Class: 1 gallon water
½ cup dishwashing liquid
¼ cup glycerin (not mandatory / helps makes large bubbles)
Prepare the mixture at least an hour prior to the activity to prepare the mixture for bubble-blowing.

Individual:
Paper towels for each student
Straws for each student
Centimeter rulers
Worksheet Bubbles (Table on 1 page / page 2 & 3 copied back-to-back)
Index card for recording diameter
To do this activity you will need students to have desktop/tabletop space where they can blow bubbles and measure the diameter of the bubbles.

Procedure:
Whole Class

1. Demonstrate blowing bubbles using a tabletop. Wipe a flat surface with a paper towel saturated with the soapy water mixture. Make sure the table is frothy with soap. Dip a straw in the liquid mixture and place the tip of the straw into the frothy soap. Blow gently and a large bubble will expand on the table in front of you. Blow until the bubble is popped. An outline of a circle will be visible.
2. *Demonstrate measuring* the diameter of the bubble print that remains after the bubble pops. and record the number on an index card.. Record the data on the back of an index card. Repeat the demonstration if necessary.

Individual

3. Have students perform the bubble blowing activity five times.
4. Students will compare the data and circle or underline the largest diameter.
5. Have a large version of the table on student resource "Bubbles" on the board or on an overhead. Record each of the student's largest bubbles on the table. Students will record the information in order to construct a stem-and-leaf plot on the second worksheet.

Name: __________________

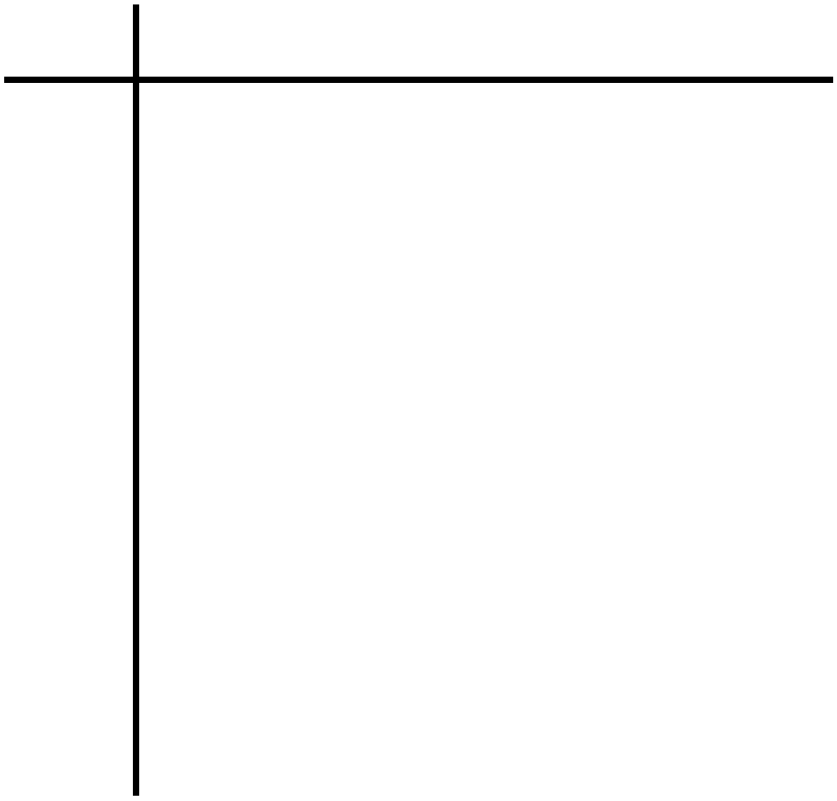
Bubbles!

Directions: Use the table below to keep track of your classmates' largest bubbles.

Student Names	Largest Bubble in cm

Stem and Leaf Bubbles!

Use the data collected from the class to create a stem and leaf plot. Be sure to include a title and a key.



Key:

Bubble Talk!

Based on your class data, what is the "typical" size of bubble a student can make? Be sure to justify your answer using math vocabulary and data collected from the class.

_____

_____

_____

_____

_____

_____

Name: _____

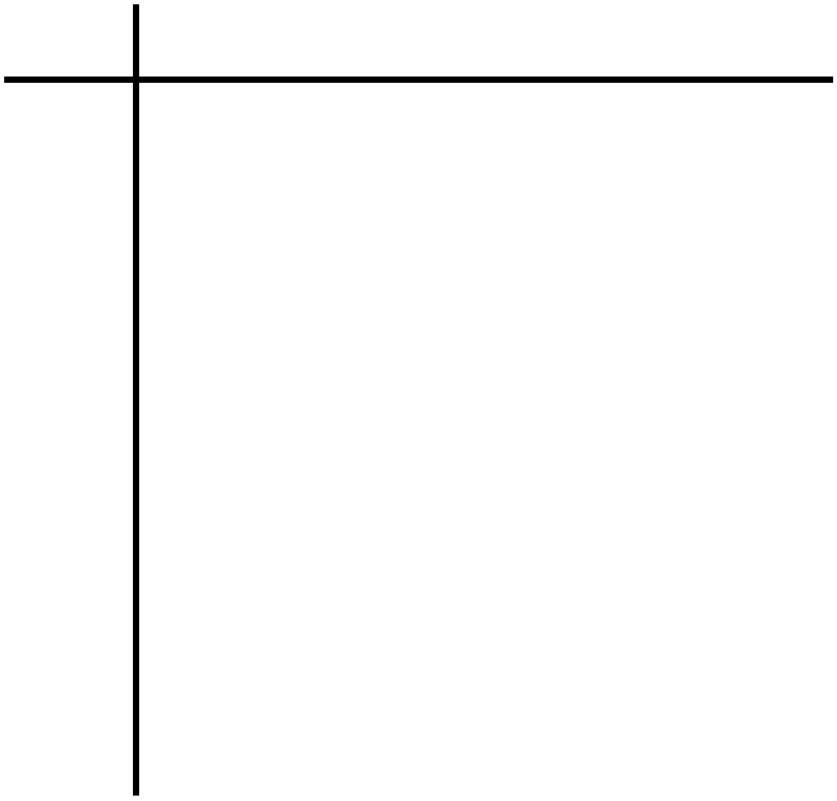
Cutting and Pasting

Directions: Use the values below to create a stem and leaf plot.
Only cut on the dotted lines! The tens digit does not get cut out!

Number of sprinkles on an ice cream cone

1	3
1	6
2	5
2	1
2	7
1	4
2	1
2	3
2	6
1	7

Cutting and Pasting



Key:

Cutting and Pasting Answer Key

Number of Ice Cream Cones Sold in June

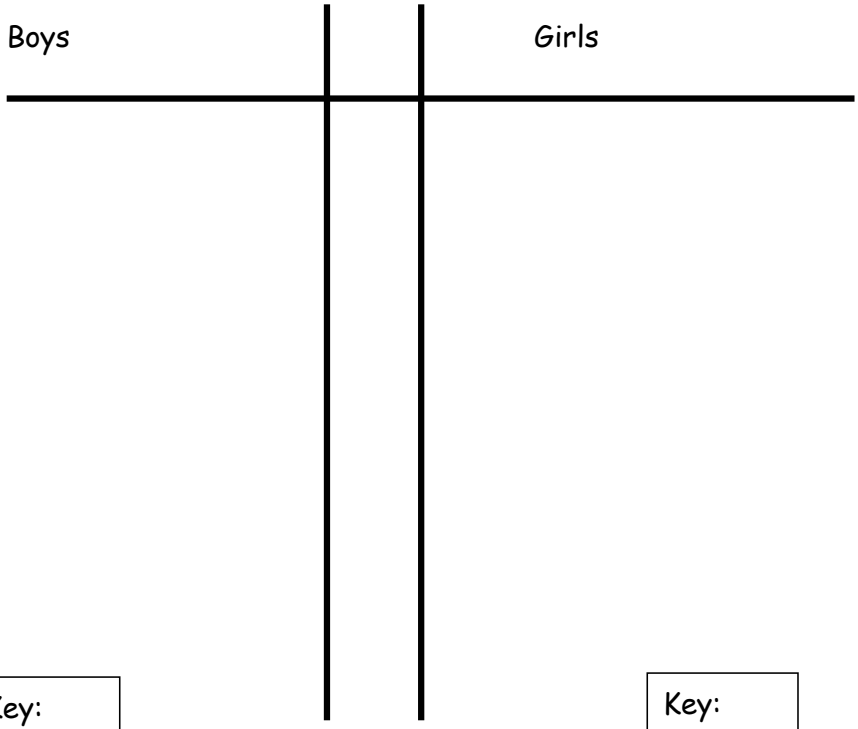
1	3 4 6 7
2	1 1 3 5 6 7

Key:
1 | 3 = 13

Name: _____

Back to Back Stem and Leaf Plot

Directions: Use your data from today's bubble activity to create a back to back stem and leaf plot below. Remember to include a key on both sides of the display!



Key:

Key:

Name: _____

Day 2 Exit Card

Directions: Use the data below to create a stem and leaf plot broken into groups of fives. Be sure to include a title and a key in your display. Then, decide what measure of central tendency best describes the data.

Number of Ice Cream Cones sold at the pool in June

54, 56, 44, 49, 57, 58, 48, 55, 53, 52, 57, 59, 53, 52, 50,

Which measure of central tendency best describes this data? (Circle your answer)

Mean Median Mode

Day 2 Exit Card Answer Key

Directions: Use the data below to create a stem and leaf plot broken into groups of fives. Be sure to include a title and a key in your display. Then, decide what measure of central tendency best describes the data.

Number of Ice Cream Cones sold at the pool in June

54, 56, 44, 49, 57, 58, 48, 55, 53, 52, 57, 59, 53, 52, 50

Number of Ice Cream Cones Sold in June

4	4
•	8 9
5	0 2 2 3 3 4
•	5 6 7 8 9

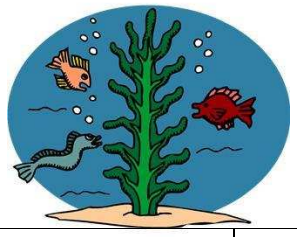
Key:

4 | 8 = 48 ice cream cones

Which measure of central tendency best describes this data? (Circle your answer)

Mean Median Mode

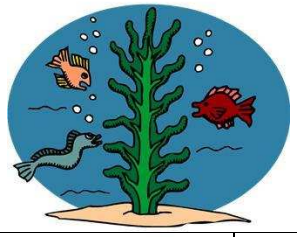
World Oceans



Name: _____

Oceans	Actual Size	Rounded to the nearest Million sq km
Indian Ocean	68,556,000 sq km	**69**
Southern Ocean	20,327,000 sq km	**20**
Pacific Ocean	155,557,000 sq km	**156**
Arctic Ocean	14,056,000 sq km	**14**
Atlantic Ocean	76,762,000 sq km	**77**

World Oceans



Name: _____

Oceans	Actual Size	Rounded to the nearest Million sq km
Indian Ocean	68,556,000 sq km	**69**
Southern Ocean	20,327,000 sq km	**20**
Pacific Ocean	155,557,000 sq km	**156**
Arctic Ocean	14,056,000 sq km	**14**
Atlantic Ocean	76,762,000 sq km	**77**

World Oceans Answer Key

Oceans	Actual Size	Rounded to the nearest Million sq km
Indian Ocean	68,556,000 sq km	**69**
Southern Ocean	20,327,000 sq km	**20**
Pacific Ocean	155,557,000 sq km	**156**
Arctic Ocean	14,056,000 sq km	**14**
Atlantic Ocean	76,762,000 sq km	**77**

14 20 69 77 156

Median = 69
Upper Quartile = 116.5
Lower Quartile = 17
Interquartile Range = 99.5
IQR x 1.5 = 149.25

149.25 – 17 = -132.25
116.5 + 149.25 = 265.75

Pacific Ocean is Not an outlier!

Definition of an Outlier

An outlier is a value that lies outside (is much smaller or much larger than) most of the other values in the data set.

Example: The number of days it rained in Maryland each month:

Month	February	March	April	May	June
Days of Rain	1	0	0	12	2

First, put the values in order from least to greatest. Then, calculate the median, upper quartile, lower quartile, and interquartile range.

0 0 1 2 12

Median 1 Upper Quartile 7 Lower Quartile 0

Interquartile Range (IQR): 7 – 0 = 7

Calculate IQR *times 1.5* = 1.5 x 7 = 10.5

Add the value to the upper quartile

7 + 10.5 = 72.5

Or *subtract* the value from the lower quartile

0 – 10.5 = -10.5

If your highest or lowest value is outside of one of those two values, you have an outlier.

May would **not** be considered an outlier!

Name: _____

Swimming Ear Plugs

Number of Earplugs used by Olympic Swimmers:

Name	Amount of earplugs
Allison Schmitt	190
Elizabeth Beisel	160
Julia Smit	250
Amanda Beard	1400
Katie Hoff	190

Median _____ Upper Quartile _____

Lower Quartile _____ Interquartile Range _____

IQR x 1.5 _____

Is Amanda's number of earplugs used over her swimming career considered to be an outlier? Be sure to include math vocabulary in your answer. Give reasons for your answer.

_____

_____

_____

_____

_____

_____

Number of Earplugs used by Olympic Swimmers: Answer Key

Name	Amount of earplugs
Allison Schmitt	190
Elizabeth Beisel	160
Julia Smit	250
Amanda Beard	1400
Katie Hoff	190

160 190 190 250 1400

Median ___190____ Upper Quartile ___825___

Lower Quartile _175_ Interquartile Range ___650_____

IQR x 1.5 __650 x 1.5 = 975_____

Is Amanda's number of earplugs used over her swimming career considered to be an outlier? Be sure to include math vocabulary in your answer.

Amanda Beard is not an outlier. She fits the criteria because when you add 975 (the IQR times 1.5) plus 825 you get 1800. One thousand four hundred is less than 1800. Therefore, Amanda would not be considered an outlier.

Name: _____

Is Dara Torres an Outlier?

Directions: Place the ages from the table of the US women's Olympic swim team from the summer of 2008 onto the stem and leaf plot. Then, calculate whether or not Dara Torres is indeed an outlier as the media has portrayed her.

Swimmers name	Age
Amanda Beard	26
Elizabeth Beisel	15
Elaine Breeden	19
Caroline Burckle	21
Natalie Coughlin	25
Kathleen Hersey	19
Margaret Hoelzer	25
Katie Hoff	19
Megan Jendrick	24
Kara Lynn Joyce	22
Christine Magnuson	22
Christine Marshall	21
Lacey Nymeyer	22
Allison Schmitt	18
Emily Silver	22
Julia Smit	20
Rebecca Soni	21
Chloe Sutton	16
Dara Torres	41
Kim Vandenberg	24
Kate Ziegler	19

1 •

2 •

3 •

4 •

Key:

Is Dara Torres an Outlier?

Median = _____ Upper Quartile = _____

Lower Quartile = _____ Interquartile Range = _____

Based on the data, is Dara Torres's age considered to be an outlier? Be sure to justify your answer using math vocabulary.

_____

_____

_____

_____

_____

_____

_____

_____

_____

Is Dara Torres an Outlier? Answer Key

Directions: Place the ages from the table of the US women's Olympic swim team from the summer of 2008 onto the stem and leaf plot. Then, calculate whether or not Dara Torres is indeed an outlier as the media has portrayed her.

Swimmers name	Age
Amanda Beard	26
Elizabeth Beisel	15
Elaine Breeden	19
Caroline Burckle	21
Natalie Coughlin	25
Kathleen Hersey	19
Margaret Hoelzer	25
Katie Hoff	19
Megan Jendrick	24
Kara Lynn Joyce	22
Christine Magnuson	22
Christine Marshall	21
Lacey Nymeyer	22
Allison Schmitt	18
Emily Silver	22
Julia Smit	20
Rebecca Soni	21
Chloe Sutton	16
Dara Torres	41
Kim Vandenberg	24
Kate Ziegler	19

US Olympic Women's Swimming Ages

1	
•	5 6 8 9 9 9 9
2	0 1 1 1 2 2 2 2 4 4
•	5 5 6
3	
•	
4	1
•	

Key:
2 | 0 = 20

Is Dara Torres an Outlier? Answer Key

Median = ___21_____ Upper Quartile = ____24_____

Lower Quartile = _____19____ Interquartile Range = _____5____

5 X 1.5 = 7.5 7.5 + 24 = 31.5

Based on the data above, is Dara Torres's age considered to be an outlier? Be sure to justify your answer using math vocabulary.

Dara Torres is an outlier. When you calculate the interquartile range (5) multiplied by 1.5 you get 7.5. That value added to the upper quartile (24) is 31.5. Therefore, anyone older than 31.5 would be considered an outlier. Dara Torres was older than 31.5 since she was 41 during the summer Olympics.

Name: _____

Outlier Finder

Directions – Use the steps below to help you figure out if the data has an outlier or not.

1. Each zoo below has Red Pandas. Decide whether or not there is an outlier within the data.

Zoo	Atlanta	Ohio	Knoxville	San Diego	Washington DC	Memphis, TN
Number of Pandas	2	1	47	3	2	2

A. Find the median : _____
B. Find the upper quartile: _____
C. Find the lower quartile: _____
D. Find the interquartile range: _____ **Subtract B – C
E. Find the IQR x 1.5 = _____
F. Add the value in E to the value in B = _____
G. Subtract the value in E from the value in C = _____
H. Are any numbers in the set of data larger or smaller than the values in F and G? Is there an outlier? If so, what number. _____

Outlier Finder

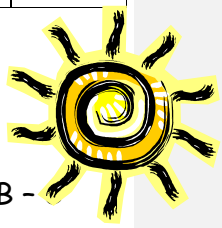
2. Find out if the speeds of the roller coasters below contain an outlier.

Roller Coaster	Cobra	Tazer	Meteor	Vicious	Holy Cow!
Speed (mph)	92	83	85	100	95

A. Find the median : _____
B. Find the upper quartile: _____
C. Find the lower quartile: _____
D. Find the interquartile range: _____ **Subtract B – C
E. Find the IQR x 1.5 = _____
F. Add the value in E to the value in B = _____
G. Subtract the value in E from the value in C = _____
H. Are any numbers in the set of data larger or smaller than the values in F and G? Is there an outlier? If so, what number. _____

3. Find out if the average temperatures in March contain an outlier.

50	51	51	58	64	70	70	70
72	74	75	75	76	78	79	100



A. Find the median : _____
B. Find the upper quartile: _____
C. Find the lower quartile: _____
D. Find the interquartile range: _____ **Subtract B –
E. Find the IQR x 1.5 = _____
F. Add the value in E to the value in B = _____
G. Subtract the value in E from the value in C = _____
H. Are any numbers in the set of data larger or smaller than the values in F and G? Is there an outlier? If so, what number. _____

Outlier Finder Answer Key

Directions – Use the steps below to help you figure out if the data has an outlier or not.

1. Each zoo below has Red Pandas. Decide whether or not there is an outlier within the data.

Zoo	Atlanta	Ohio	Knoxville	San Diego	Washington DC	Memphis, TN
Number of Pandas	2	1	47	3	2	2

A. Find the median : __2.5_____
B. Find the upper quartile: ___4____
C. Find the lower quartile: ___2_____
D. Find the interquartile range: ___2____ **Subtract B – C
E. Find the IQR x 1.5 = __3_____
F. Add the value in E to the value in B = ___7___
G. Subtract the value in E from the value in C = ___-1____
H. Are any numbers in the set of data larger or smaller than than the values in F and G? Is there an outlier? If so, what number. _Yes, Knoxville 47_____

Outlier Finder Answer Key

2. Find out if the speeds of the roller coasters below contain an outlier.

Roller Coaster	Cobra	Tazer	Meteor	Vicious	Holy Cow!
Speed (mph)	92	83	85	100	95

A. Find the median : __92_____
B. Find the upper quartile: ___97.5____
C. Find the lower quartile: __84_____
D. Find the interquartile range: __13.5___ **Subtract B – C
E. Find the IQR x 1.5 = __20.25_____
F. Add the value in E to the value in B = __117.75____
G. Subtract the value in E from the value in C = __63.75_____
H. Are any numbers in the set of data larger or smaller than than the values in F and G? Is there an outlier? If so, what number. ___No, there is not an outlier_____

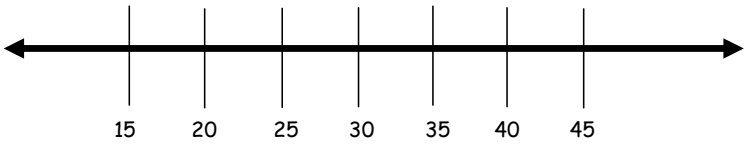
3. Find out if the average temperatures in March contain an outlier.

50	51	51	58	64	70	70	70
72	74	75	75	76	78	79	100

A. Find the median : __71_____
B. Find the upper quartile: __75.5_____
C. Find the lower quartile: ___61____
D. Find the interquartile range: __14.5___ **Subtract B – C
E. Find the IQR x 1.5 = ___21.75____
F. Add the value in E to the value in B = __97.25____
G. Subtract the value in E from the value in C = ___-7.25____
H. Are any numbers in the set of data larger or smaller than than the values in F and G? Is there an outlier? If so, what number. _Yes, there is an outlier. 100 is more than 97.25!

Name: _____

U.S. Women's Olympic Swim Team Ages

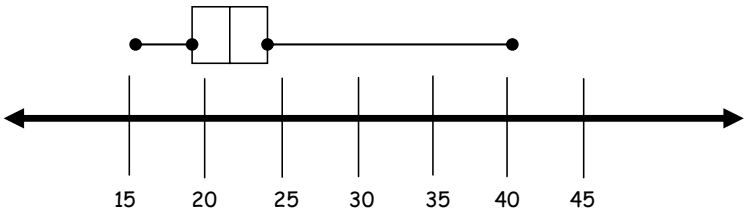


Directions: Using the U.S. Women's Olympic Swim Team Ages construct a Box-and-Whisker plot on the number line above.

1. Find the median of the data set, and place a dot above that number on the number line. _____
2. Find the upper and lower extremes of the data set and put a dot above each of those numbers on the number line. _____ _____
3. Find the median of the numbers less than the median of the data set, which is the median of the lower quartile and put a dot above that number. _____
4. Find the median of the numbers more than the median of the data set, which is the median of the upper quartile and put a dot above that number. _____
5. Draw a one centimeter line from the lower extreme to the median of the lower group of data.
6. Draw a line from the upper extreme to the median of the upper group of data.
7. Draw a vertical line through the three medians.
8. Connect the tops and bottoms of your vertical lines.

Name: _____

U.S. Women's Olympic Swim Team Ages



Directions: Using the U.S. Women's Olympic Swim Team Ages construct a Box-and-Whisker plot on the number line above.

9. Find the median of the data set, and place a dot above that number on the number line. __21_
10. Find the upper and lower extremes of the data set and put a dot above each of those numbers on the number line. _15__ _41__
11. Find the median of the numbers less than the median of the data set, which is the median of the lower quartile and put a dot above that number. _19__
12. Find the median of the numbers more than the median of the data set, which is the median of the upper quartile and put a dot above that number. _24__
13. Draw a one centimeter line from the lower extreme to the median of the lower group of data.
14. Draw a line from the upper extreme to the median of the upper group of data.
15. Draw a vertical line through the three medians.
16. Connect the tops and bottoms of your vertical lines.

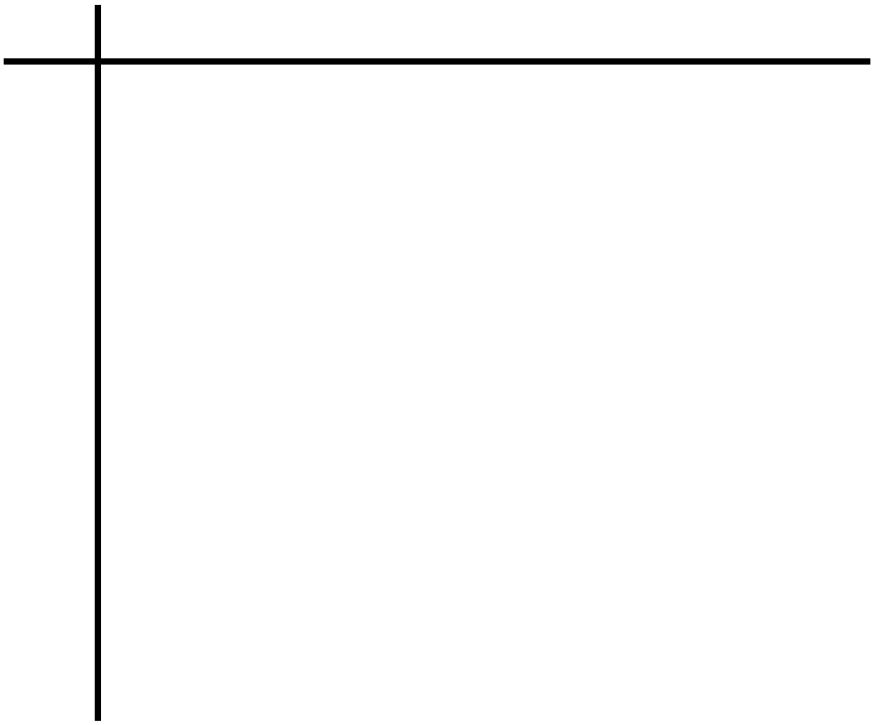
Name: _____

Summative Assessment

Directions:
Use the data from the 2010 Winter Olympics to create a stem and leaf plot.

Country	Number of Medals
United States	37
Germany	30
Canada	26
Norway	23
Austria	16
Russian Federation	15
Korea	14
China	11
Sweden	11
France	11
Switzerland	9
Netherlands	8
Czech Republic	6
Poland	6
Italy	5
Japan	5
Finland	5
Australia	3
Belarus	3
Slovakia	3
Croatia	3
Slovenia	3
Latvia	2
Great Britain	1
Estonia	1
Kazakhstan	1

Summative Assessment



Are there any outliers within this data? Use mathematics to justify your answer.

_____

_____

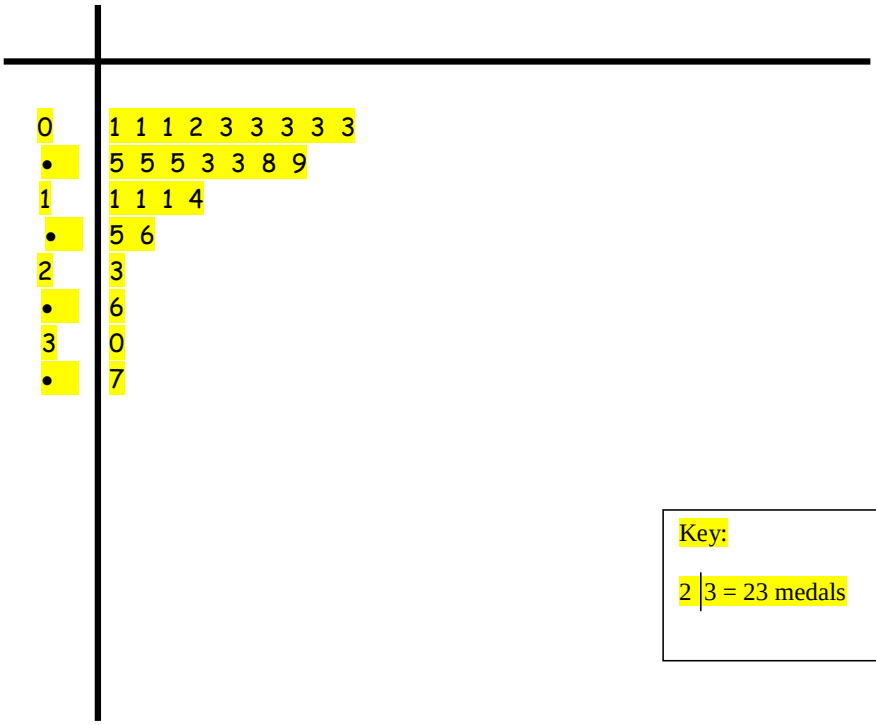
_____

How many medals would a country "typically" win during the winter Olympics based on this data. Use mathematics to justify your answer.

_____

Summative Assessment Answer Key

2010 Winter Olympics Medal Totals



Key:

2 | 3 = 23 medals

Are there any outliers within this data? Use mathematics to justify your answer.
Yes, there are two outliers in this data. The upper quartile is 14 and the lower quartile is 3. The interquartile range is 11. Eleven times 1.5 = 16.5. When you add 16.5 plus 14 you get 30.5. The lower quartile minus 16.5 is -13.5. There are two values above 30.5, the United States (37) and Germany (30).

How many medals would a country "typically" win during the winter Olympics based on this data. Use mathematics to justify your answer.

A typical country could expect to win 6 medals during the winter Olympics. This is because the median is the measure of central tendency that best describes the data. There are two outliers that skew the data which makes the median the best.